Section II. REMARKS

<u>Response to the §103 Rejection of Claims and Traversal Thereof</u>

In the March 11, 2004 Office Action, the Examiner rejected pending claims 61, 63-67, 70, and 71 on various art grounds. Specifically, the Examiner rejected:

> claims 61 and 63-67 under 35 U.S.C. §103(a) as being obvious over **Akasaki** et al. U.S. Patent No. 4,855,249 (hereinafter "Akasaki") in view of **Gmitter** et al. U.S. Patent No. 4,883,561 (hereinafter "Gmitter") or **Bozler** et al. U.S. Patent No. 4,837,182 (hereinafter "Bozler"); and

> claims 70-71 under 35 U.S.C. §103(a) as being obvious over **Akasaki** in view of **Gmitter** or **Bozler**, and further in view of **Manasevit** U.S. Patent No. 3,922,475 (hereinafter "Manasevit").

In response, Applicants have hereby amended independent claims 61, 63, and 70, from which claims 64-67 and 71 respectively dependent.

Applicants respectfully traverse the Examiner's rejections of claims 61, 63-67, 70, and 71, for the following reasons:

Amended claim 61 of the present application expressly requires:

> "A method of making a single crystal GaN substrate, comprising **<u>growing single crystal GaN</u>** <u>over</u> **<u>a substrate heterogeneous</u>** <u>to GaN</u>, and **<u>removing the heterogeneous substrate</u>** <u>to yield the single crystal GaN substrate</u>."

Amended claims 63 (from which claims 64-67 depend) and 70 (from which claim 71 depend) recite corresponding requirements.

It is therefore clear that Applicants' claimed method **<u>concurrently</u>** requires the following three important technical features:

(1) **use of a heterogeneous substrate** (i.e., in relation to GaN);

(2) **growth of single crystal GaN** over such heterogeneous substrate; and

(3) **removal of the heterogeneous substrate**.

The primary reference **Akasaki** only discloses a process for growing single crystal AlGaN layers on heterogeneous sapphire substrates, but it does not in any manner teach, suggest, or even contemplate the removal of such heterogeneous sapphire substrates, as expressly conceded by the Examiner in the March 11, 2004 Office Action (see the Office Action, page 2, last sentence).

In attempt to remedy such deficiency of **Akasaki**, the Examiner cited two secondary references **Gmitter** and **Bozler**, which disclose methods for removing epitaxial or crystalline films from the respective substrates. The Examiner asserted that it would have been obvious to a person of ordinary skill in the art at the time of the present invention to use the methods disclosed by **Gmitter** and **Bozler** for removing the single crystal AlGaN layer formed by the **Akasaki** process from the heterogeneous sapphire substrate, so as to yield Applicants' claimed method (see the Office Action, page 3, lines 5-9 and 18-22).

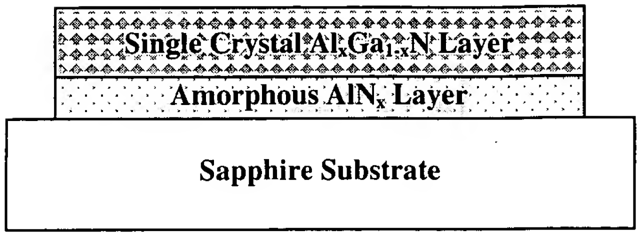
Applicants rigorously disagree with such assertion.

The methods disclosed by Gmitter and Bozler are only applicable to the specific substrate/film structures disclosed by Gmitter and Bozler, which are **fundamentally different from the substrate/film structure formed by the Akasaki process**.

Such fundamental differences render Gmitter and Bolzer's methods inoperable for separating the substrate/film structure disclosed by Akasaki.

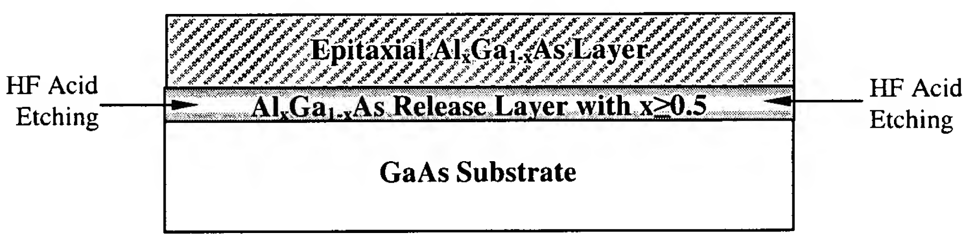
Specifically, the **Akasaki** reference discloses formation a single crystal $Al_xGa_{1-x}N$ layer on a sapphire substrate, by first heat-treating the sapphire substrate at 900-1000°C with $Al(CH_3)_3$, NH_3, and H_2 inflow so as to form an amorphous AlN_x (X>0) layer on the sapphire substrate, and then growing the single crystal $Al_xGa_{1-x}N$ layer on top of such amorphous AlN_x layer at a growth temperature of 970-1,030°C with $Ga(CH_3)_3$, NH_3, and H_2 inflow (see Akasaki, column 3, lines 30-43, Table 1, and column 4, lines 6-21).

Therefore, the substrate/film structure formed by the **Akasaki** process can be illustrated as follows:



The **Gmitter** reference discloses a method for selectively lifting off an epitaxial film from a single crystal substrate, by forming a thin release layer between such epitaxial film and the substrate, and then etching away such release film while causing edges of the epitaxial film to curl upward as the release layer is etched away (see Gmitter, column 2, lines 27-39). Specifically, **Gmitter** discloses use of a single crystal <u>GaAs substrate</u> for growing <u>$Al_xGa_{1-x}As$ epitaxial films</u> thereon, while <u>a thin release film formed of $Al_xGa_{1-x}As$ with $x \geq 0.5$</u> is provided between such GaAs substrate and $Al_xGa_{1-x}As$ epitaxial films (see Gmitter, column 5, lines 10-22 and 30-50). Such $Al_xGa_{1-x}As$ release film of high Al content can be etched away by using <u>concentrated HF acid</u> (see Gmitter, column 3, lines 46-47, and column 5, line 35).

Therefore, the substrate/film structure that is separable by the method disclosed by **Gmitter** can be illustrated as follows:



It is clear that the presence of <u>**the high Al-content $Al_xGa_{1-x}As$ release layer**</u>, which is etchable by HF acid, in a substrate/film structure is critical for successful separation of such substrate/film structure using the method disclosed by **Gmitter**.

In contrast, <u>**the substrate/film structure formed by the Akasaki process**</u> only contains an amorphous AlN layer between the sapphire substrate and the single crystal $Al_xGa_{1-x}N$ layer, and <u>**does not contain any high Al-content $Al_xGa_{1-x}As$ release layer**</u>.

A person ordinarily skilled in the art, after reading the **Akasaki** and **Gmitter** references, would immediately recognize the fundamental differences between the substrate/film structure formed by the

Akasaki process and the substrate/film structures that can be separated by the **Gmitter** method, and would not be motivated to use the **Gmitter** method for separating the substrate/film structure formed by the **Akasaki** process.

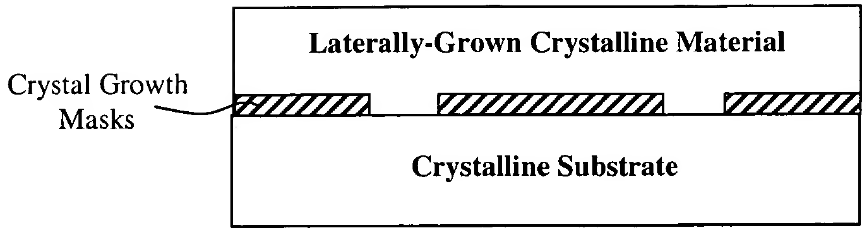
Further, there is no teaching or suggestion of any type in **Akasaki** for modification of the substrate/film structure so formed. On the contrary, **Akasaki** indicates that the crystalline characteristic of the $Al_xGa_{1-x}N$ layer depends on the specific substrate configuration, i.e., the sapphire substrate having an amorphous AlN_x buffer layer thereon (see Akasaki, column 2, lines 34-57, and column 4, lines 6-41).

A person ordinarily skilled in the art, after reading Akasaki, therefore would not be motivated to modify the substrate configuration disclosed by Akasaki, due to lack of any suggestion in the reference for such modification, and lack of any reasonable expectation of success that single crystal $Al_xGa_{1-x}N$ layers can be formed on modified substrate configurations. In other words, a person ordinarily skilled in the art would not be motivated to add a high Al-content $Al_xGa_{1-x}As$ release layer into the substrate/film structure disclosed by **Akasaki**, because addition of such Al-content $Al_xGa_{1-x}As$ release layer would affect the crystalline characteristic of the $Al_xGa_{1-x}N$ layer, potentially in a severely adverse manner, and there is no reasonable expectation of success for forming single crystal $Al_xGa_{1-x}N$ layer on such high Al-content $Al_xGa_{1-x}As$ release layer.

The Examiner's hypothetical combination of the Akasaki and Gmitter references is therefore improper.

The **Bozler** reference discloses a process for laterally growing a sheet of crystalline material on top of a single crystal substrate that is partially masked by a crystal growth mask, and then separating the sheet of crystalline material from the substrate (see Bozler, column 6, lines 12-51). Specifically, such crystal growth mask is either characterized by low adhesion to the substrate (e.g., a carbonized photoresist layer having low adhesion to GaAs substrate) that can be subsequently cleaved from the substrate, or can be subsequently removed otherwise by etching, melting, or sublimation, etc. (see Bozler, column 6, lines 51-62; Figures 2 and 15; column 7, lines 34-36).

Therefore, the substrate/film structure that is separable by the method disclosed by **Bozler** can be illustrated as follows:



It is clear that the presence of **such crystal growth masks**, which is subsequently cleavable or otherwise removable, in a substrate/film structure is critical for successful separation of such substrate/film structure using the method disclosed by **Bolzer**.

In contrast, **the substrate/film structure formed by the Akasaki process** only contains an amorphous AlN layer between the sapphire substrate and the single crystal $Al_xGa_{1-x}N$ layer, and **does not contain any crystal growth masks that are subsequently cleavable or otherwise removable**.

A person ordinarily skilled in the art, after reading the **Akasaki** and **Bolzer** references, would immediately recognize the fundamental differences between the substrate/film structure formed by the **Akasaki** process and the substrate/film structures that can be separated by the **Bozler** method, and would not be motivated to use the **Bozler** method for separating the substrate/film structure formed by the **Akasaki** process.

Further, as mentioned hereinabove, there is no teaching or suggestion of any type in **Akasaki** for modification of the substrate/film structure so formed, and **Akasaki** instead suggests that the crystalline characteristic of the $Al_xGa_{1-x}N$ layer depends on the specific substrate configuration, i.e., the sapphire substrate having an amorphous AlN_x buffer layer thereon.

A person ordinarily skilled in the art, after reading Akasaki, therefore would not be motivated to modify the substrate configuration disclosed by Akasaki, due to lack of any suggestion in the reference for such modification, and lack of any reasonable expectation of success that single crystal $Al_xGa_{1-x}N$ layers can be formed on modified substrate configurations. In other words, a person ordinarily skilled in the art would not be motivated to add crystal growth masks onto the substrate structure of **Akasaki**, because addition of such crystal growth masks would affect the crystalline

characteristic of the $Al_xGa_{1-x}N$ layer, potentially in a severally adverse manner, and there is no reasonable expectation of success for forming single crystal $Al_xGa_{1-x}N$ layer on such crystal growth masks.

The Examiner's hypothetical combination of the Akasaki and Bozler references is therefore improper.

The **Manasevit** reference does not remedy the above-explained deficiency of **Akasak**, **Gmitter**, and **Bozler**.

Therefore, **the Examiner has not established a *prima facie* case of obviousness against claims 61, 63-67, 70, and 71 of the present application**, and Applicants respectfully request the Examiner to withdraw the §103 rejection of claims 61, 63-67, 70, and 71.

CONCLUSION

Based on the foregoing, claims 61, 63-67 and 70-71 as amended herein are now in form and condition for allowance. The Examiner is requested to issue a Notice of Allowance accordingly.

No fee is rendered payable for entry of this Response. Nevertheless, the Office is hereby authorized to charge any necessary fees associated with this Response to the Deposit Account No. 08-3284 of Intellectual Property/Technology Law.

If any additional issues remain, incident to the formal allowance of the application, the examiner is requested to contact the undersigned attorney at (919) 419-9350 to discuss same.

Respectfully submitted,

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